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Pakistan floods and extreme weather in August 2010

Why have there been such severe floods in Pakistan; record-breaking high temperatures in Moscow resulting in forest fires and damaged crops, and major floods in China? Our Chief Scientist Professor Julia Slingo investigates these significant events.

In mid-summer 2010 parts of Pakistan were devastated by the worst floods for generations.

Pakistan typically receives about half its annual rainfall of 250–500 mm during July and August so reports of 24-hour totals in excess of 300 mm on 29 July particularly in the head waters of the Indus River were exceptional.

Simply saying that this was part of an active Indian Monsoon season cannot alone explain the exceptional nature of the rainfall. Most summers see active spells of the Indian Monsoon where the rains spread north and west into Rajasthan, the Punjab and Pakistan. But what happened in August 2010 appears to be much more than where an active spell of the monsoon interacted with a very disturbed pattern of weather from the mid-latitudes.

Airflow

Usually during the summer, the airflow high in the atmosphere (the troposphere) over northern India, the Himalayas and Pakistan, is dominated by the monsoon anticyclone which pushes the sub-tropical jet stream to the north of the Tibetan Plateau. This prevents weather systems from reaching very far south. 2010, however, was different with the upper level airflow over the whole of Asia being very disturbed.

The results of this were record-breaking high temperatures in Moscow leading to fatalities, forest fires and damaged crops. On July 29 the temperature soared to 38.2 °C (the average high being 20 °C). That, according to Russian meteorologists is a once in a thousand year event. That same pattern affected Pakistan, with a deep trough forming downstream of the anticyclone over western Russia.

Another consequence of this disturbed weather pattern was the excessive rainfall over China, causing major mudslides and the Three Gorges Dam to almost reach its capacity of 185 m.

Pakistan floods

In Pakistan on 28/29 July this trough moved to the east and south down into northern parts of the country. The colder, unstable air aloft interacted with the warm moist air from the Indian monsoon to the south, which activated a line of intense storms along the mountains of Pakistan, feeding into the Indus River. A similar situation developed on 3 August leading to further heavy rain that hampered relief efforts.

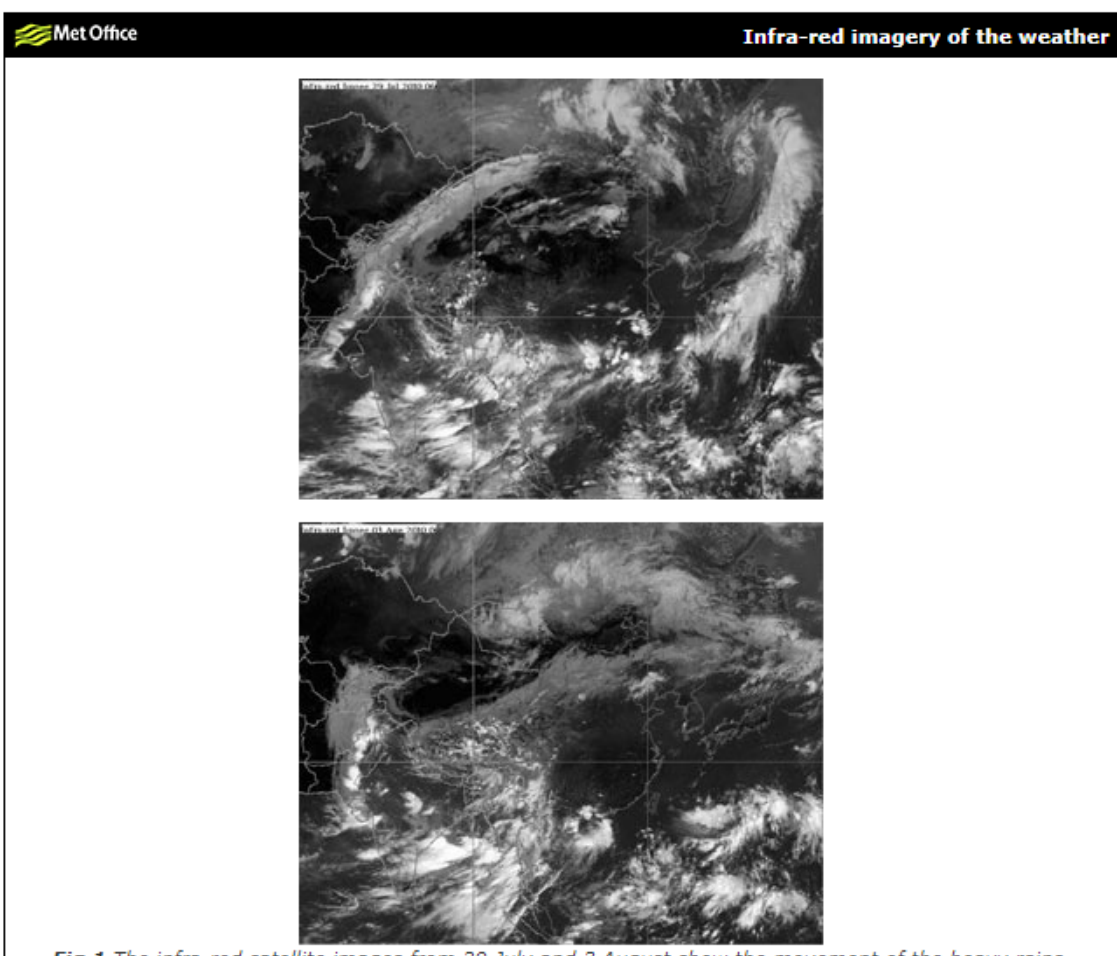

Fig 1 *The infra-red satellite images from 29 July and 3 August show the movement of the heavy rains.*

So, it would seem that Pakistan floods were the result of an unfortunate conjunction of an active Indian monsoon with an unusual weather pattern that occurred just over the mountains of western Pakistan and fed vast amounts of rainfall into the head waters of the Indus River.

Were other factors involved?

La Niña

The whole Asian Summer Monsoon system was very active and this could be attributed, in part, to the La Niña developing in the equatorial Pacific Ocean since the early summer. La Niña is the opposite phase of El Niño and is characterised by cooler than normal ocean temperatures in the central and East Pacific. The effect of this is to contain the warmest waters in the western Pacific which then drives a stronger than normal monsoon. Weather patterns circle the globe and it is possible that the disturbed nature of the pattern in August 2010 was driven by the strong monsoon — this is a process known as teleconnection.

Climate change

Another reasonable question to ask is whether global warming had any part in this extreme weather. It's very hard to attribute any particular extreme event to climate change and, as in all cases, there is a plausible explanation for the natural variabilty of our weather and climate.

However, there is evidence from observations, especially in India and China, that periods of heavy rain are getting heavier. This is entirely consistent with our understanding of the physics of the atmosphere in which warmer air holds more moisture. Our climate change predictions support this emerging trend in observations and show a clear intensification of extreme rainfall events in a warmer world.

So, although climate change is very unlikely to have been *solely* responsible for the recent extreme weather, it is likely that climate change is loading the dice and shortening the odds of heatwaves and heavy rainfall events around the globe.

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